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Voice Based Navigation System for Blind People Using Ultrasonic Sensor

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Abstract: As the technology is advancing day to day, the human machine interaction has become a must in our daily life. The interference has progressively become more important and advanced in order to ease the interaction process of the user and provide friendly operation. There are a few advanced technologies which are now accessible in the market to cater the needs, yet they have their own particular drawbacks, thus one of the efficient solutions is to use an embedded system. The primary objective of this work is to permit blind persons to explore autonomously in the outside environment. Ordinary route navigational systems in the outdoor environment are expensive and its manufacturing is time consuming. Blind people are at extensive drawback as they regularly do not have the data which is required, while passing obstacles and dangers. They generally have little information about data such as land marks, heading and self velocity information that is crucial for them to explore them through new environment. It is our conviction that advances in innovations could help and encourage these blind people in their regular operations. This work goes for giving the route to blind persons, by designing a cost – effective and more flexible navigation system. Here we are developing a navigation system that makes use of sounds in order to provide navigation instruction to the user. The conversion of speech into a text is done by a pocket sphinx and Google API, whereas the text to speech conversion is done by Espeak and here we are trying to convert the speech into an Indian language (Hindi). Route navigation is taken care by a Raspberry pi. The route questions queries of the destination location are geocoded utilizing Geo-coder module and then passed to Espeak (text to speech) module to create a pedestrian route. The user can include the location by talking into a microphone connected to raspberry pi. The whole system is mounted to a pack that sits on the client waist. It is light and convenient and it doesn't obstruct any of the client's detects while it is being utilized.

Keywords- *Espeak, GoogleAPI, Pocket sphinx, Raspberry pi, ultrasonic sensor, GPS, Geocoder, Reverse geocoder.*

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I. INTRODUCTION

A. Background

There are approximately 38 millions of people across the worldwide mainly in developing countries who are blind and visually impaired, over 15 million are from India. Blind persons most of the time are withdrawn from the society because they feel that people and the society are prejudiced and they may not be welcomed most of the time .The remarkable achievement, which is the outcome of persistent struggle and hard work between "Anne Sullivan" – the teacher and "Helen Keller "-the blind student resulted in a revolutionary method of learning and communication, which ultimately culminated in the development of Braille language. Blind person do not need pity, but require empathy, so as to mingle in the society and be independent for their routine chores (activity).Hence blind people need an assistive device that will allow blind user to navigate freely and this requirement has become crucial. Most of the blind people depend on other individuals, white cane or guide dogs to travel freely. Currently, there are several visual information that helps visually impaired people to move in a right way (e.g. takes a right direction, take left, move forward, move backward and avoid obstacles,) but they all limit the freedom of the user. Walking securely and unhesitatingly with no human help within urban environment is a troublesome undertaking for visually impaired and blind individuals. The fundamental goal is to give an ease or financially savvy approach that will permit visually impaired individuals to explore freely or independently in the outdoor environment. Based on this real context or condition we focused the work on developing assisting technologies that may help blind individuals bringing them back to the society. Our main objective is to make a compact, self-sufficient system that will permit these blind people to travel through an environment .This voice based route navigation system can provide solution to this problem. This System is based on embedded system and provides navigation instructions to the user by giving audio instructions through speaker which is connected to raspberry pi using a USB jack. This navigation system will detect an obstacle using HC-SR 04 ultrasonic sensor and guide blind person by providing an audio instructions through 3.5 mm speakers.

B. *Motivation*

In order to improve the quality of life for visual impaired or

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blind people, in this work we focused on developing new technologies to help these persons to access the outdoor environment in particular such as Banks, hospitals, post office, and other public utility. Therefore this work intends to play a special role in this field providing as much information as possible for visually impaired or blind people, which allows them to take a comfortable navigation. To build a prototype we focused on users and their interests, this work aims to build a system to assist people with disabilities. The system intends to help them in providing the information. In this system we are going to detect an obstacle using ultrasonic sensor. Obstacle detection sensor acts as the heart of the system.

C.Problem statement

Outdoor navigation is becoming a harder task for blind and visually impaired people in the increasingly complex urban world. Advances in technology are causing the blind to fall behind, sometimes even putting their lives at risk. Technology available for navigation of the blind is not sufficiently accessible some devices rely heavily on infrastructural requirements.

II. PROPOSED METHOD

Here the figure1 shows the block diagram of the project which mainly includes different modules. The software's used in this project includes "embedded c" coding for obtaining GPS data and "python" coding to measure the distance of the object and for obstacle detection .Pocket sphinx and Google API are used for converting the speech to text and Espeak for converting text to speech. Here text to speech synthesis has been used for English and Hindi language. Entire system consists of different modules. This architecture is divided into 6 major modules: Initialization, User Interface, Address query translate, and Route Query, and Route transversal, obstacle detection.

Each module plays a distinct a fundamental function. They are described next

1) Initialization: The first step includes initializing the system library.
2) User Interface: Obtain the destination address from user using a microphone, this microphone is connected to a raspberry pi. Here it emphasizes the Voice Module remarking the importance of touch independent and visual independent interfaces as the system is designed especially for blind and partially sighted people. The voice interface implemented uses services such as Text To Speech for the voice outputs and the Google Voice Recognizer API.

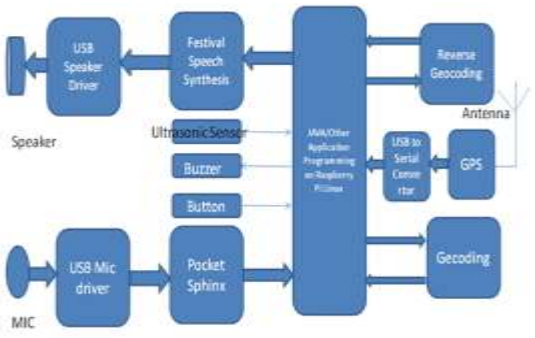

Fig 1 Block diagram of proposed method.

Text To Speech synthesizes speech from text. It is used whenever there is information to be displayed. A server client approach is followed by voice module, where Voice Recognizer part communicates with the server to processes information and send it back to the user as text.

3) Address query translate: The address query translates geographic to coordinate this includes the geocoding part, converting the destination address into latitude and longitude, this in turn provides the detail information of the destination address the information module comprises all the data related to points of interest outside the building that is outdoor environment. Every location, bus stand, counters, schools, colleges is associated to one specific category, If a visually impaired or blind person wants to go from one place to another place, the database must be predefined .This information must be clear and concise, once it will be used for the selection of services it will be delivered to the user by synthesized speech.

4) Route Query: Route query takes the blind user current Co-ordinate from GPS and the destination Co- ordinate, and compute the routes. The localization module is designed to, constantly monitor the position of a user using GPS module. Different Places have different latitude and longitude hence as the person move from one places to another place the latitude and longitude changes according to the place. As a result of this, many new designs can take the advantage of being tractable.

5) Route transversal: Route transversal provides audible instructions to user in the form of speech so that the blind person can travel independently. Once the destination address is obtained this address must be translated to geographic point. The destination address will be geocoded using the GEO-CODER module and then passed to text to speech synthesizer to generate a pedestrian route.

6) Object detection: For obstacle detection ultrasonic sensor has been used, this ultrasonic sensor emits ultrasonic beams to the environment, which are reflected back by the object; the system calculates the distance from the object according to the time difference between the emitted and received beam. The stereo-vision systems use the object tracking

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procedure and calculate the distance and it there is any obstacle within the range, then system will read out as "Obstacle detected".

Fig 2.Results for obstacle detection.

III. Hardware

The hardware used here are: Raspberry pi, HC-SR 04 ultrasonic sensor, GPS Kit, Microphone, USB jack, 3.5 Mm mini speaker. The raspberry pi is a credit card-sized single board computer developed in the UK by the raspberry pi foundation with the intention of promoting the teaching of basic computer science in schools.

A. *GPS (Global Positioning System)*

The Global Positioning System (GPS) is a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the earth where there is an unobstructed line of sight to four or more GPS satellites. The system provides critical capabilities to military, civil, and commercial users around the world. The United States government created the system, maintains it, and makes it freely accessible to anyone with GPS receiver. The Global Positioning system (GPS) is a network of 30 satellites orbiting the earth at an altitude of 20,000km Whenever you are on the planet, at least four GPS satellites are 'visible' at a time .Each one transmits information about its position and the current time at regular intervals. These signals, travelling at the speed of light, are intercepted by your GPS receiver, which calculates how far away each satellite is based on how long it took for the message to arrive. The GPS (Global Positioning system) receiver continuously receives the latitude and longitude values for every position of the system and it is interfaced with the raspberry pi.

The Global Positioning System (GPS) offers the capability to accurately determine location anywhere on earth in addition to speed, altitude, heading, and a host of other critical positioning data. The GPS receiver requires a successful lock onto at least four GPS satellites to gather an accurate signal for calculating position and velocity. The module triangulates its position with relation to three satellites, using a fourth satellite as a clock source.

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Where:

RMC Recommended Minimum sentence C
121413Fix taken at 12:14:13 UTC
A Status A=active or V=Void.
2400, 0000, N Latitude 24 deg 00.00' N
12100.0000, E Longitude 12 deg 10.000' E
022.4 Speed over the ground in knots
280315Date - 28th of March 2015
*7C the checksum data, always begins with *

B .*Ultrasonic Definition*

The human ear can hear sound frequency of around 20HZ ~ 20KHZ. And ultrasonic is the sound wave beyond the ability of which human's can hear is of 20KHZ and are not harmful for human being. The Ultrasonic Transmitter which will send a signal out into its surrounding area. The Ultrasonic Receiver will detect this signal once it bounces off from an object/obstacle. Ultrasonic sensors are basically used to measure the distances between the obstacle object and the sensor. The ultrasonic sensor works based on the principle of Doppler Effect. It consists of an ultrasonic transmitter and a receiver. The transmitter transmits the signal in one direction and this transmitted signal is then reflected back whenever there is an obstacle and it is received by the receiver. So the total time taken by the signal to get transmitted and to received back will be used to calculate the distance between the ultrasonic sensor and the obstacle. Ultrasonic sensor provides a very low-cost and easy method of distance measurement. Many animals have the ability to hear ultrasonic frequency range for example bats.

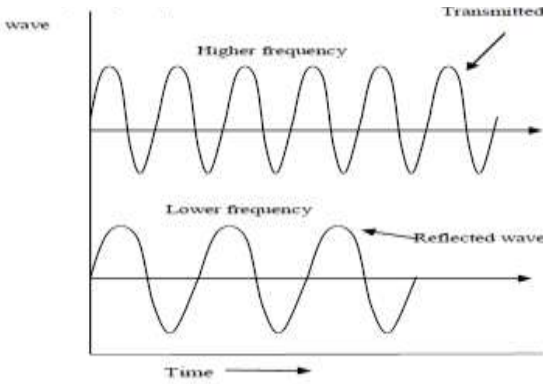

Fig 3 waveform of ultrasonic sensor.

Set low the Trig port and Echo port when the module

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initializes , firstly, transmit at least 10μs high level pulse to the Trig pin (module automatically sends eight 40K square wave), and then wait to capture the rising edge output by echo port, at the same time, open the timer to start timing. Next, once again capture the falling edge output by echo port, at the same time, read the time of the counter, which is the ultrasonic running time in the air. According to the formula: test distance = (high level time * ultrasonic spreading velocity in air) / 2, we can calculate the distance to the obstacle.

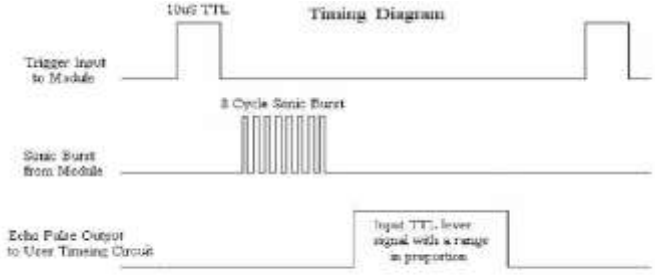

Fig 4 Timing diagram of ultrasonic sensor.

IV. SOFTWARE

A. *Text to speech*

The function of a TTS system is to convert the given text into a spoken waveform. In order for us to give verbal instructions to the user, we need to convert our text instructions into audible speech. We decided to use Espeak. The major benefit of using Espeak is that it is open source and it allows you to output speech in many different languages. Therefore we sent a string of data to Espeak with the instruction which we wanted to tell the user and this text to speech synthesiser converted the text into speech data, which was then played for the user. The database has been created for different addresses which include bus stops, colleges, hospitals, etc. This conversion involves text processing and speech generation processes. This approach seeks to develop strategies for concatenating stored speech segments as a means of Synthesizing speech. Sub-word units, such as syllables or diaphones, in which co-articulation between adjacent phonemes are preserved, are considered as satisfactory units, under this approach to synthesizing speech,

Using the same tool the text to speech conversion was done into an Indian language (Hindi).

Fig 5 data used for creating Hindi database.

B. *Speech to text*

However, when we require specific information such as address, we must rely on a more versatile method for input. Speech to text allowed us to get input from the user simply by asking them to say the required piece of information into a microphone. Speech to text allows us to record the user's speech and convert it to text which can be used for the other parts of the system. We mainly used speech to text to get the user's desired destination address.

Speech recognition:
We used the open source speech to text engine, pocket sphinx [2] developed by Carnegie Melon University. We choose this particular open source engine because it allowed us to easily add new words to the dictionary of required words and also allowed us to train the engine to better recognize the speech of a particular user. To use pocket sphinx we needed to create input files for the engine .To "Teach" the engine a new word, we had to generate a phonetic dictionary containing the word and a language model containing the word as well .we also needed an acoustic model, but the one that came with pocket sphinx would be sufficient. The phonetic dictionary file is a simple mapping of the word to its corresponding phones. The phoneme for a word is just the distinct set of units of sound that describes that word and distinguishes it from other words. For example

- SAMPLE S AE M P AH L

Finally for the acoustic model which contains the entire acoustic model which contains all the acoustic properties of each senone. Pocket sphinx came with a default acoustic model. Here we can train the model to any user speech with ease. After doing the speech to text conversion using pocket sphinx synthesiser, it was found that the accuracy was not good. And it could only recognize the words which are predefined in the dictionary .so the Google voice recognition API was tried and tested, which had great accuracy compared to pocket sphinx.

C. *Google voice recognition API (speech to text):* Speech recognition can be achieved in many ways on Linux (so on the Raspberry Pi), the accuracy is very good, and has a strong accent; it starts recording and saves the audio in a flac file format. The audio file is then sent to Google for conversion and text will be returned and saved in a file called "stt.txt".

D.*Gecoding*: (also called forward Gecoding) is the procedure of advancing a description of an area, most normally a postal address or place name, with geographic co ordinates from spatial reference information, for example, road location, and postal codes and so on. A geocoder is a piece of software programming or a (web) benefit that implements a Gecoding procedure. The Geo coder module is an open source that has the capacity parse location to geospatial co ordinates. A basic system for Gecoding is location insertion. This strategy makes utilization of information from a road geographic data framework where the road system is now mapped inside of the geographic direction space. Every road section is attributed with location ranges (for example house numbers starting with one segment then onto the next). Gecoding takes a location, matches it to a road and particular fragment, (for example, a block numbers in towns utilize the "blocks" convention).

E. *Reverse geocoding: Reverse* Gecoding is the process of back (reverse) coding of a point location (latitude, longitude) to a readable address or place name. The identification of a point of interest in a given geographical area, utilizing GPS services includes the help of reverse geocoding process at any given specific point, the place of interest may not actually reflected using GPS services but the point of interest in a geographical area can be attained comparing with a known location, street, state or country or a popular nearby landmark. There are various agencies like API's or Google, which encodes and maps a particular geographical area ,using latitude and longitude localization of landmarks, steer address ,state country for the benefit of GPS users .When a person switches on GPS services a person's location is reflected through a process of reverse geocoding which determines his location compared to already pre-programmed

V. CONCLUSION AND FUTURE WORK

Overall the project has been a success with the entire project requirement. The future scope for this project is to improve the capabilities by this system by incorporating landmark as saved destination. We would like find a more accurate cost effective GPS receiver as well as faster portable Linux computer. We would also like develop an algorithm for position and velocity so that other methods of navigation such as dead reckoning can be implemented accurately. And to use the online route, for obtaining the route from the Google maps, so that the blind person can travel to the places which are not stored in the database.

Advantages:

- Low design time
- Low production cost
- This system is applicable for both the indoor and outdoor environment
- Setting the destination is very easy
- This system be capable of using in public Places
- It is a dynamic system
- Less space
- Low power consumption

Applications:

- This system can be used in the home, hospitals and colleges
- This system can be used in both the known and unknown environments like airports, malls and public parks etc.

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